The Effect of Infrapatellar Fat Pad Excision on Complications After Minimally Invasive TKA: A Randomized Controlled Trial

Piya Pinsornsak MD, Kittipon Naratrikun MD,
Sukanis Chumchuen MD

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Abstract

Background The infrapatellar fat pad is one of the structures that obscures exposure in minimally invasive total knee arthroplasty (MIS TKA). Most MIS TKA surgeons (and many surgeons who use other approaches as well) excise the fat pad for better exposure of the knee. There is still controversy about the result of fat pad excision on patella baja, pain, and function.

Questions/purposes In the setting of a randomized controlled trial, we sought to determine whether infrapatellar fat pad excision during MIS TKA causes (1) patellar tendon shortening (as measured by patella baja); (2) increased anterior knee pain; (3) decreases in the Knee Society Score or functional subscore; or (4) more patella-related complications.

Methods We randomized 90 patients undergoing MIS TKA at one institution into two groups. In one group, 45 patients underwent MIS TKA with complete infrapatellar fat pad excision and in the other group, 45 patients received MIS TKA without infrapatellar fat pad excision. The patella was selectively resurfaced in these patients; there was no difference between the groups in terms of the percentage of patients whose patellae were resurfaced. We measured patellar tendon shortening, knee flexion, anterior knee pain, Knee Society Score (KSS), functional subscore, and patellar complications at preoperative and postoperative periods of 6 weeks, 3 months, 6 months, and 1 year; complete followup data were available on 86% of patients (77 of 90) who were enrolled.

Results At the final followup, no significant differences were observed in patellar tendon shortening, KSS, functional subscore, or knee flexion in either group. However, patients with their infrapatellar fat pad excised experienced more anterior knee pain (8.3% versus 0%; $p = 0.03$; 95% confidence interval, -0.007 to 0.174) at the end of the study. No patellar complications were found in either group.

Conclusions Infrapatellar fat pad excision in MIS TKA resulted in an increasing small percentage of patients with anterior knee pain after surgery. Surgeons should keep the fat pad if excellent exposure can be achieved but resect it if needed to improve exposure during TKA.

Level of Evidence Level I, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

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P. Pinsornsak (✉), K. Naratrikun, S. Chumchuen
Department of Orthopaedic Surgery, Thammasat University,
99 Moo 18, Khlong Nueng, Khlong Luang, Pathumthani 12120,
Thailand
e-mail: pinpiya2003@yahoo.com

Introduction

Minimally invasive TKA (MIS TKA) may reduce soft tissue injury by making a smaller surgical incision and by

requiring less soft tissue dissection; there is some evidence that it is associated with less postoperative pain and faster recovery after surgery [13]. However, difficulties with exposure can cause component malalignment and early failure after TKA [18]. The infrapatellar fat pad is a fatty mass lying beneath the patellar ligament, between the inferior pole of the patellar and tibial tubercle. In the MIS TKA approach, this fatty mass can obscure the surgical field during tibial bone cut, interpose between cement and the bony surface during tibial baseplate implantation, and interfere with the insertion of the liner on the tibial baseplate at final implantation, so its removal is commonly performed, both during MIS TKA exposure and traditional TKA exposure.

However, removal of the fat pad may cause patella baja, reduction of flexion, and persistent pain [6]. The infrapatellar fat pad contains transverse infrapatellar arteries, which supply the inferior pole of the patella [20]. Excision of the fat pad decreases the vascularity of the patella and may result in patellar avascular necrosis and fracture [8, 12, 17]. Scarring of the fat pad may cause patellar infera and limit ROM after TKA [6]. The fat pad acts as a cushion between the patellar tendon and anterior tibial plateau [5]. Excision of the fat pad can cause anterior impingement, anterior knee pain, and worse results after the operation [4, 16]. However, again, the importance of adequate surgical exposure tends to drive many surgeons to remove it during surgery. Because of these issues, the choice of whether to remove the infrapatellar fat pad during TKA remains controversial, and practice patterns vary widely [19]. One recent systematic review found mixed results on the topic of pain, patella baja, and function, indicated that the literature was quite limited, and called for a randomized controlled trial [21].

We therefore conducted this randomized controlled study to determine the effect of infrapatellar fat pad excision on (1) patellar tendon shortening (as measured by patella baja); (2) anterior knee pain; (3) Knee Society Score and functional subscore; and (4) patella-related complications.

Materials and Methods

This was a randomized controlled study. From March 2009 to February 2010, a total of 90 patients, aged 40 to 80 years, scheduled for TKA were enrolled into the study. We invited all patients scheduled for TKA to participate provided that they did not meet our prespecified exclusion criteria, which were unsuitability for MIS TKA (four patients), prior open surgery on the knee (three patients), or severe stiffness (flexion < 90°, flexion contracture > 10°, one patient). In addition to these exclusions, five other patients were invited to participate but declined to do so.

Patients were randomized to either MIS TKA with complete infrapatellar fat pad excision (45 patients) or a group without infrapatellar fat pad removal (45 patients) by computer-generated assignment labeled with sequentially numbered, sealed envelopes. All patients provided written informed consent before enrollment. The study was approved by the local institutional review board (registration number MTU-EC-OT-6-025/56). Complete followup data were available on 86% of patients at 1 year (77 of 90). Demographic data show an average age of 67 years with one man and 35 women in the complete infrapatellar fat pad excision group and an average age of 68 years with four men and 37 women in the no infrapatellar fat pad excision group. There are no differences in terms of age, sex, preoperative Insall-Salvati ratio, anterior knee pain, preoperative flexion, preoperative Knee Society Score, or preoperative functional subscore (Table 1). A total of 94% were diagnosed with primary osteoarthritis and 6% with rheumatoid arthritis.

The surgery was performed by a single surgeon (PP) who had experience in MIS TKA. The same surgical techniques were used throughout the study. The primary outcome measure was patellar tendon shortening assessed by using Insall-Salvati ratio [10] (Fig. 1) preoperatively, immediately postoperatively, and at 6 weeks, 3 months, 6 months, and 1 year after surgery, whereas the secondary outcome measures were knee ROM and anterior knee pain defined as pain at the anterior of the knee with the activity of going up and down stairs or changing position. We defined anterior knee pain when the patient felt disturbing pain, which affected daily life activity. The total Knee Society Score [9] as well as the functional subscore and other patellar complications including patellar fracture and avascular necrosis was assessed at the same time points. Our primary study hypothesis was that there would be a difference in the patellar tendon length and other parameters in both groups until final followup. A sample size of 27 participants in each group was calculated to provide 80% power to detect a 5%

Table 1. Preoperative demographic data

Parameter	FPR group	FPNR group	p value
Age (years)	67.1 ± 8.4*	68.2 ± 7*	0.992 [†]
Male:female	1:35	4:37	0.215
OA:RA	32:4	40:1	0.123
Preoperative Insall-Salvati ratio	0.991 ± 0.093*	0.998 ± 0.079*	0.726
Preoperative flexion	122 ± 16*	116 ± 16*	0.158 [†]
Preoperative KSS	59 ± 15.*	65 ± 18*	0.187
Preoperative functional score	43 ± 23*	47 ± 26*	0.511

* Values are expressed as the mean ± SD; [†]Mann-Whitney U test used when data were not normally distributed; FPR = fat pad removed group; FPNR = fat pad not removed group; OA = osteoarthritis; RA = rheumatoid arthritis; KSS = Knee Society Score.

difference in change of the patellar tendon length between the groups based on the previous study of 7% patellar tendon length shortening after TKA [22].

For purposes of this study, we defined MIS TKA as a TKA in which we used a shorter, anteromedially based incision in which we used specially designed MIS instruments (The side-cutting MIS Quad-Sparing™ instrument; Zimmer, Warsaw, IN, USA) and standard implants, in which we did not evert the patella and performed a limited medial parapatellar approach 2 cm above the superior pole of the patella.

One gram of cefazolin was administered intravenously 10 minutes before surgery. After the tourniquet was inflated, a limited medial parapatellar skin incision (approximately 10 cm in length) was performed beginning 2 cm proximal to the superior pole of the patella and passing along the medial border of the patella to the medial border of the tibial tubercle. No patellar eversion was performed in either group. In the complete infrapatellar fat pad excision group, the total infrapatellar fat pad was removed underneath the patellar tendon before femoral preparation (Fig. 2). In the no infrapatellar fat pad excision group, we preserved the entire fat pad by retracting it out of the operative field throughout the operation (Fig. 3). Femoral and tibial preparation for MIS

TKA was performed in accordance with the standard resection technique. A cemented prosthesis was used in all cases. The patella was selectively resurfaced in the patients who had preoperative anterior knee pain or intraoperative findings of articular surface erosion to the subchondral bone. The patella was resurfaced in 21 of 36 patients (58.3%) in the complete infrapatellar fat pad excision group and 20 of 41 patients in the no infrapatellar fat pad excision group (48.8%). There was no difference between groups in terms of patellar resurfacing ($p = 0.2$).

Preoperatively, there were no significant differences in the Insall-Salvati ratio, preoperative knee flexion, anterior knee pain, total Knee Society Score, or functional subscore.

The patients were followed up at 6 weeks and 3, 6, and 12 months after surgery.

We recorded the postoperative Insall-Salvati ratio [10] and postoperative patellar complications that include avascular necrosis and patellar fracture by using a lateral knee digital roentgenogram in 30° knee flexion. The postoperative knee flexion, anterior knee pain, total Knee Society Score as well as the functional subscore were also recorded at each visit.

Of the 90 patients, 77 (36 in the complete infrapatellar fat pad excision group, 41 in the no infrapatellar fat pad

Fig. 1 Insall-Salvati ratio is the ratio between the length of patellar tendon (LT) and the longest diagonal length of the patella (LP).

Fig. 2 In the total infrapatellar fat pad excision group, the total infrapatellar fat pad was removed underneath the patellar tendon.

Fig. 3 In the no infrapatellar fat pad excision group, the entire infrapatellar fat pad was preserved through the operation.

excision group) completed the study. Thirteen patients were discontinued from the study; 12 of them were lost to followup (eight patients in the complete infrapatellar fat pad excision group, four patients from the no infrapatellar fat pad excision group; $p = 0.11$), and one (complete infrapatellar fat pad excision group) had accidentally fallen down the steps with traumatic medial collateral ligament and patellar tendon rupture 3 months after surgery.

The 95% confidence interval of the group differences was calculated for each variable. The Kolmogorov-Smirnov goodness-of-fit test was used to determine normal distribution. Student's *t*-test was used to perform two-group comparisons for independent samples (with Welch correction when variances were unequal) when data were normally distributed, and the Mann-Whitney *U* test was used when data were not normally distributed. All statistical analyses were performed using SPSS Version 17.0 software (SPSS Inc, Chicago, IL, USA).

Results

There was no difference in patella baja as measured by the Insall-Salvati ratio between the two groups. The sequential

lateral radiographs from the preoperative period to 1 year postoperatively did not show any significant change in the mean Insall-Salvati ratio in either group over time (Table 2).

Preoperative anterior knee pain, which is defined as pain at the anterior of the knee with the activity of going up and down stairs or changing position and the patient feels disturbing pain that affects daily life activity, was found in 50% of the complete infrapatellar fat pad excision group and 36.6% of the no infrapatellar fat pad excision group. After the operation, anterior knee pain decreased in both groups (11.1% in the complete infrapatellar fat pad excision group, 7.3% in the no infrapatellar fat pad excision group) at 6 weeks, and at that time point, the difference was not significant between the groups ($p = 0.28$). At 3 months, 6 months, and 1 year, however, the complete infrapatellar fat pad excision group still experienced anterior knee pain, whereas none was reported in the no infrapatellar fat pad excision group (Table 3). The difference was statistically significant ($p = 0.01$, 0.01 , and 0.03 , respectively). Sub-group analysis of the patient with anterior knee pain at 1 year in the group with complete infrapatellar fat pad excision found two patients with a resurfaced patella and one without a resurfaced patella (Table 4).

In four patients with rheumatoid arthritis and in the completed fat pad excision group, two did not have their patella resurfaced and only one of two had anterior knee pain at 6 weeks after operation and no pain after 6 weeks to 1 year. One with rheumatoid arthritis in the no fat pad excision group had no anterior knee pain both pre- and postoperatively.

The mean knee flexion (Table 5), total Knee Society Score (Table 6), and functional subscore (Table 7) between the groups showed no differences out to 1 year postoperatively.

We observed no complications, fractures of the patella, or avascular necrosis in either group during the study.

Discussion

The infrapatellar fat pad that serves as a cushion between the patellar tendon and anterior tibial plateau can obscure the exposure of the surgical field in TKA. Removal of the fat pad enhances exposure, especially in MIS TKS, but there is some evidence that its removal may result in complications such as patellar baja [7], limited knee ROM [6], anterior knee pain [16], avascular necrosis, and fracture of the patella [8, 11, 17]. The evidence is inconclusive, however, about whether removal of the fat pad indeed causes problems; a recent systematic review found mixed results on the topic of pain, patella baja, and function and indicated that the literature was quite limited and called for

Table 2. Mean Insall-Salvati ratio

Group	Preoperatively	Postoperatively	6 weeks	3 months	6 months	1 year
FPR	0.99	1	0.98	0.94	1.01	1
FPNR	1	1	0.99	0.94	1.02	0.98
p value	0.726	0.720	0.760	0.979	0.686	0.412

FPR = fat pad removed group; FPNR = fat pad not removed group.

Table 3. Anterior knee pain*

Group	Preoperative	6 weeks	3 months	6 months	1 year
Fat pad excision group	18/36 (50.0%)	4/36 (11.1%)	4/36 (11.1%)	5/36 (13.9%)	3/36 (8.3%)
No fat pad excision group	15/41 (36.6%)	3/41 (7.3%)	0/41 (0%)	0/41 (0%)	0/41 (0%)
p value	0.12	0.28	0.01	0.01	0.03

* Anterior knee pain which define as pain at the anterior of the knee with the activity of going up and down stair or changing position. We defined the anterior knee pain when the patient feels disturbing pain, which affects daily life activity.

Table 4. Anterior knee pain* compared between resurfaced and nonresurfaced groups

Group	Preoperative R:NR	6 weeks R:NR	3 months R:NR	6 months R:NR	1 year R:NR
Fat pad excision group	12:6	3:1	3:1	3:2	2:1
No fat pad excision group	7:8	1:2	0:0	0:0	0:0

* Anterior knee pain which is defined as pain at the anterior of the knee with the activity of going up and down stairs or changing position. We defined anterior knee pain when the patient felt disturbing pain that affected daily life activity; R = resurfaced patella; NR = nonresurfaced patella.

Table 5. Mean knee flexion

Group	Preoperatively	6 weeks	3 months	6 months	1 year
FPR	122	113	117	122	120
FPNR	115	111	117	119	121
p value	0.158*	0.647*	0.925*	0.387*	0.505*

* Mann-Whitney U test used when data were not normally distributed; FPR = fat pad removed group; FPNR = fat pad not removed group.

a randomized controlled trial [21]. We therefore sought to determine the effect of infrapatellar fat pad excision on (1) patellar tendon shortening (as measured by patella baja); (2) anterior knee pain; (3) total Knee Society Score and functional subscore; and (4) patella-related complications.

We recognize the limitations of this study. First, anterior knee pain is a subjective measurement; even when we identified the anterior knee pain as a disabling pain that disturbs activities of daily living, we did not have the scale for measurement, which is difficult to interpret. Patients with zero anterior knee pain in the no infrapatellar fat excision group may have subtle anterior knee pain but it is not severe enough to affect activities of daily living. Second, we selectively resurfaced the patella depending on the

Table 6. Knee Society Score

Group	Preoperatively	6 weeks	3 months	6 months	1 year
FPR	57	89	90	71	92
FPNR	64	89	91	81	94
p value	0.187	0.890	0.737	0.125	0.248

FPR = fat pad removed group; FPNR = fat pad not removed group.

Table 7. Functional score

Group	Preoperatively	6 weeks	3 months	6 months	1 year
FPR	42	50	64	71	75
FPNR	47	58	75	81	78
p value	0.511	0.073	0.073	0.189	0.948

FPR = fat pad removed group; FPNR = fat pad not removed group.

preoperative anterior knee pain status and the intraoperative findings of the patella, which could affect the outcome of anterior knee pain. However, subgroup analysis found remaining anterior knee pain at 1 year in the complete infrapatellar fat pad excision group. Two had resurfaced patellae and one had no resurfaced patella. Resurfacing the

patella may not be the major factor that affects the outcome.

Third, we used the Insall-Salvati ratio as a surrogate measure for patellar tendon shortening, which may not be a reliable parameter for postoperative TKA because osteophyte removal around the patellar bone affects the patellar bone length. However, other parameters (Blackburne Peel ratio [1] and Caton-Deschamps [2]) are even less reliable for such measurements postoperatively because the joint line may change after TKA, which affects these parameters that required a consistent joint line for accurate evaluation [8].

Patellar tendon length was not found to be different between the groups and did not change over time out to the end of the first year (which was the duration of our study). Our findings therefore do not support the theory that intraarticular fibrosis and scarring after infrapatellar fat pad removal cause patellar tendon shortening [7, 11]. One clinical study reported that patellar tendon shortening occurred in the group of patients whose fat pads were resected but not in the group whose infrapatellar fat pads were preserved during surgery [14]. In the study, TKA in each group was performed by different surgeons, who may have different surgical techniques and resulted in different results. Another study [16] and also our study did not find shortening in either group of patients. Our study found that the patients in the complete infrapatellar fat pad excision group had more anterior knee pain after 6 weeks to 1 year compared with the no infrapatellar fat pad excision group, which had no anterior knee pain up to final followup. The pain could be caused by the lack of a fat pad, which acts as a cushion between the patellar tendon and anterior surface of the tibial components [5]. This study supported findings from a previous retrospective study [16], which indicated that nearly twice the patients with complete infrapatellar fat pad excision experienced postoperative knee pain when compared with patients with no infrapatellar fat pad excision (mean followup of 5.1 years). The report of infrapatellar fat pad resection in patients with rheumatoid arthritis who undergo TKA compared with no fat pad resection with synovectomy found the resection had more anterior aching discomfort, limited knee motion, quadriceps weakness, and shortening of patellar tendon length at the final followup at 28 to 38 months [18].

Some studies found different results. The recent systematic review of the effect of infrapatellar excision in TKA [21] found no difference in anterior knee pain, ROM, or function in the patient with osteoarthritis but decreasing function in the patient with rheumatoid arthritis. Measuring anterior knee pain in our study has two confounding factors, which may interfere with interpretation. First, anterior knee pain is the subjective measurement that is difficult to quantify and second is selective patellar resurfacing.

For knee flexion, total Knee Society Score, and functional subscores, we found no differences between the groups at any time point we studied. No difference in mean postoperative knee flexion indicated that the resection of the fat pad did not cause stiffness after TKA as reported in the literature [6].

An anatomic vascular study showed that the majority of the fat pad can be removed with no injury to the inferior part of the anastomosis ring [12]. The disruption of infrapatellar blood supply may not affect the vascularity of patellar bone. Our study showed no evidence of avascular necrosis and patellar fracture in the total infrapatellar fat pad excision patients, which corresponds to that reported in the literature [3]. The study on postoperative technetium bone scans after TKA with infrapatellar fat pad excision [15] also found that the excision did not compromise patellar blood supply, patellar tendon contracture, Knee Society Score, or functional score after the operation.

In conclusion, we found an increased frequency of anterior knee pain in patients whose infrapatellar fat pads were resected at the time of MIS TKA; however, the difference was small and potentially confounded by selective patellar resurfacing and imperfect measurement tools. We found no differences in terms of patella baja, knee ROM, Knee Society Scores, or patella-related complications. Based on this, we believe that surgeons should keep the fat pad if excellent exposure can be achieved, but resect it if needed to improve exposure during TKA. Future, larger studies, directed specifically at the question of anterior knee pain after TKA, may shed further light on this important topic.

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